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Testing Electrolytic Motor-Starting Condensers

By the Engineering Department, Aerovox Corporation

THE electrolytic condenser differs greatly from the oil-filled paper condenser in construction and characteristics. It is essential to keep this in mind when testing, for tests which are employed for ordinary paper condensers are not suitable for electrolytic condensers and will lead to erroneous conclusions. Before investigating the result of each type of test on both types of condensers it is best to review briefly the action and construction of electrolytics.

THE D.C. ELECTROLYTIC CONDENSER

The action of the electrolytic condenser depends on the forming of a very thin film of aluminum oxide on one of the plates when the unit is subjected to an electric current. This film is non-conductive and since it is so very thin, the capacity becomes large in proportion to the size and weight because the capacity is inversely proportional to the thickness of the dielectric. The d.c. condenser consists of two foils separated by the electrolyte, one of the foils having a film on its surface. This unit can be used in electric circuits with certain reservations:

1. It has "polarity", i.e. it is good only for d.c. which may be pulsating, as long as the polarity never reverses. A reversed current will ruin the formed foil.
2. It has a rather high leakage, high power factor, compared to the other types of condensers, but there are many uses of condensers where this is of little importance. The leakage is proportional to the capacity. Hence the leakage of very large condensers will be large enough to be easily measured.
3. The condenser cannot stand testing at two or three times rated voltage as can a paper condenser.

Condensers of this type have been used for several years in power supply circuits with a great saving of space, weight and expense.

The high capacity in a small bulk is an advantage which gave promise for the development of condensers having capacities up to 200 and even 1000 microfarads of reasonable size and expense for industrial purposes. The "split-phase" or "condenser-start" motor is the most efficient and convenient type of a.c. motor for household uses, if an economical large condenser can be had. This requirement is met by the a.c. electrolytic condenser.

A.C. ELECTROLYTIC CONDENSERS

When both foils are formed, the unit can be subjected to a.c. for short periods of time. This eliminates reservation number one mentioned above, but introduces this new limitation:

Due to its inherent characteristics the condenser will heat up when in use and will be ruined if left connected across the rated voltage for any length of time. Therefore all electrolytic condensers for motor starting are limited to intermittent service, the usual rating being a maximum of 20 starts per hour, and a maximum starting period of 3 seconds at 130 degrees Fahrenheit.

The limitation of applied voltage still holds for a.c. condensers. Units designed for voltages below 110 volts will stand no more than 125% of the rated voltage. Condensers rated at more than 110 volts should not be subjected to potentials higher than 110% of their rating.

CONSTRUCTION

Figure 1 illustrates the internal construction of industrial electrolytics of two different types. The two foils are separated by a layer of gauze and a layer of paper or by two layers of paper saturated with the electrolyte. It is then placed in the can and surrounded by packing which prevents it from shifting around. Several precautions have to be taken when placing the unit in the can. If the can were of a different metal than the foils, a galvanic action would take place which is not desired. Therefore, the can and the terminals must be made of aluminum.

The amount of moisture in the electrolyte determines the power factor and therefore the efficiency of the condenser. It is then imperative that this amount of moisture be carefully maintained after the condenser has been placed into service. This can only be done by preventing loss of moisture due to evaporation and gain due to leakage from the outside. Hermetic sealing is the only means of maintaining the desired degree of moisture. The drawings illustrate how perfect sealing has been attained.

No effort has been made to prevent the electrolyte from touching the can.

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Since the electrolyte is a conductor, if this happens the can is "hot" but it does not indicate any defect in the condenser.

Summarizing the important differences between oil-filled and electrolytic starting condensers, we have:

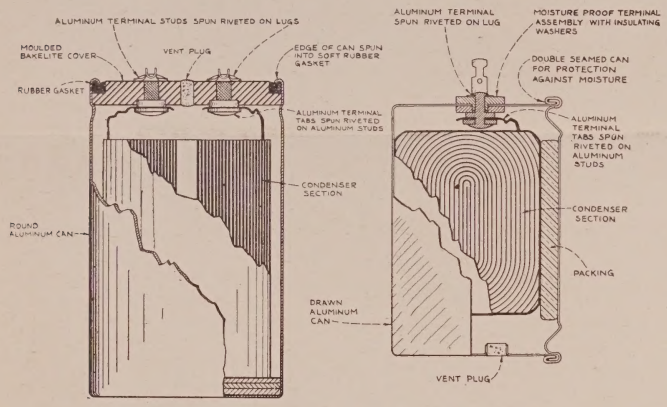

ALUMINUM TERMINAL STUDS SPUN RIVETED ON LUGS
MOULDED BAKELITE COVER
VENT PLUG
EDGE OF CAN SPUN INTO SOFT RUBBER GASKET
RUBBER GASKET
ALUMINUM TERMINAL TABS SPUN RIVETED ON ALUMINUM STUDS
CONDENSER SECTION
ROUND ALUMINUM CAN
ALUMINUM TERMINAL SPUN RIVETED ON LUG
MOISTURE PROOF TERMINAL ASSEMBLY WITH INSULATING WASHERS
DOUBLE SEAMED CAN FOR PROTECTION AGAINST MOISTURE
ALUMINUM TERMINAL TABS SPUN RIVETED ON ALUMINUM STUDS
CONDENSER SECTION
PACKING
DRAWN ALUMINUM CAN
VENT PLUG

Fig. 1

Electrolytic condensers can economically be made having very large capacities, much larger than those of any other type of condenser. When connected across the line, they will have less reactance, therefore higher current and higher heat development.

The leakage per microfarad is larger than that of oil-filled condensers and since the leakage too is proportional to the capacity, the total will be rather large to a man accustomed to paper condensers.

The oil-filled condenser has the oil touching the can but this does not make any difference since the oil is an insulator and the can is therefore not connected to any of the terminals at any time—if it is, the unit is defective. The electrolytic condenser may have some of the electrolyte touching the can, but the electrolyte is a conductor and thus the can may have a potential with respect to a terminal. This does not impair the function of the condenser but it should be installed with the can insulated.

The oil-filled condenser will stand an overload of up to three times the rated voltage for short periods of time. The electrolytic will not even stand 25 per cent. very long and even at rated voltage it cannot be left continuously connected to the line.

TESTING CONDENSERS

The best way to test electrolytic condensers is by connecting them across the line in series with an a.c. ammeter and noting the current. The current is proportional to the capacity and the voltage and the frequency but for a given frequency and voltage the test amounts to the measurement of capacity. The capacity for different currents is given in the graph of Figure 2. This graph has been calculated for 110 volts, 60 cycles only. The same relation has also been shown in table form in Table I where the correct current is shown for condensers of standard sizes.

A practical difficulty is the case when the condenser is shorted which would blow out the meter. As protection a quick acting relay is recommended—fuses do not act fast enough. For those who do not have such a relay available, a short circuit test will be described presently.

It is of course not to be expected that the currents will be exactly what the table I indicates. The condensers are manufactured and tested for capacities between 95% and 120% of the rated capacity. Consequently the current might be 5% low or up to 20% too high. In fact if it is somewhat higher, the capacity is larger which should make the motor start better. These limits of 5% low and 20% high are shown in table II. It will be noted from this, that there are overappings, for instance, a condenser of 60 mfd. may have a capacity as large as that of one rated at 70 mfd., if the first happened to be somewhat high and the other somewhat low. This overlap should not lead one to think that it would be satisfactory to employ condensers with smaller ratings.

For a short test, connect the condenser in series with a 500 or 600 watt heater unit and across the 110 volt line. Then measure the voltage across the heater unit. If the line voltage is read, the condenser is shorted. If the meter reads less than line voltage, the condenser has capacity and can now be further tested for the exact capacity by the ammeter test, if desired. The essential point is to place the condenser in series with a device drawing rather heavy current such as the heater unit. A 50 watt lamp is unsatisfactory but a 500 watt lamp would do or five 100 watt lamps in parallel would be satisfactory. This is so because the capacity is so large, the reactance in ohms of a good condenser so small, that the voltage drop is not appreciable except for heavy currents.

COMPARING TESTS ON OIL CONDENSERS AND ELECTROLYTICS

The following tests, commonly performed on paper dielectric condensers are meaningless when tried on an electrolytic condenser. They are here described with their results when applied to both types.

a. Applying a capacity meter to an oil condenser will result in an indication of its capacity. If the current passing through the condenser is larger than that for the highest indicated division of the meter, the meter indicates "short."

The electrolytic condenser has so large a capacity that it is sure to make the meter go off scale because the average capacity meter has a range of no more than 16 or 20 mfd. and the average industrial electrolytic may have 80 to 150 mfd. capacity. This makes the meter go off scale where it says short.

b. Connect a 25 or 50 watt lamp in series with the line and an oil-filled condenser and it will light dimly or not at all. If the lamp lights at full brilliance, the condenser is shorted.

Doing the same with the electrolytic condenser will always result in full brilliance because the capacity is so large that the voltage drop is nearly zero with a light load. A heavier current should be tried as described above.

c. Connect a 25 watt lamp in series with an oil-filled condenser and 110 volts d.c.; the lamp remains dark if the condenser is good; will light dimly if there is a high resistance short and lights brightly in the event of a total short.

The electrolytic condenser has enough leakage, if a large one is tested, to light the lamp dimly, even if the condenser is good.

d. Testing with the same equipment for a grounded condenser—connection between one plate and the can—the lamp will remain dark for a good condenser. The electrolytic condenser may or may not show any current but if it does the condenser may still be good since some electrolyte may be in contact with the can and this does not interfere with the operation of the condenser as a motor-starting device.

e. Oil condensers are sometimes subjected to a "breakdown test" at three times the rated voltage. They will stand up under this test if the voltage is applied for short periods. The electrolytic will not stand such a high voltage since the formation voltage controls the maximum voltage to be applied.

TABLE I

Capacity mfd.	Current amps.
10	0.41
20	0.83
30	1.24
40	1.66
50	2.07
60	2.45
70	2.90
80	3.32
100	4.15
115	4.77
135	5.40
150	6.22
175	7.26
200	8.29
250	10.37
300	12.44
400	16.59
500	20.73
600	24.88
700	29.03
800	33.18
1000	41.47

TABLE II

Capacity mfd.	Min. Current amps.	Max. Current amps.
10	.39	.50
20	.79	1.0
30	1.2	1.5
40	1.6	2.0
50	2.0	2.5
60	2.4	3.0
70	2.8	3.5
80	3.1	4.0
100	3.9	5.0
115	4.5	5.7
135	5.1	6.7
150	5.9	7.5
175	6.8	8.7
200	7.9	10.0
250	9.9	12.4
300	11.8	14.9
400	15.7	19.9
500	19.6	24.9
600	23.6	29.9
700	27.6	34.8
800	31.4	39.8
1000	38.9	49.8

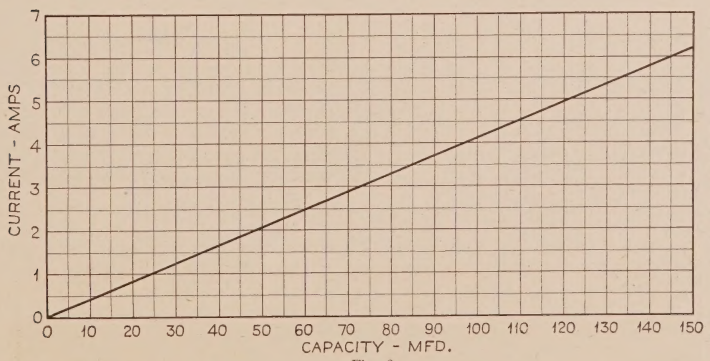


Fig. 2

Radio's Five-Inch Shelf of Books

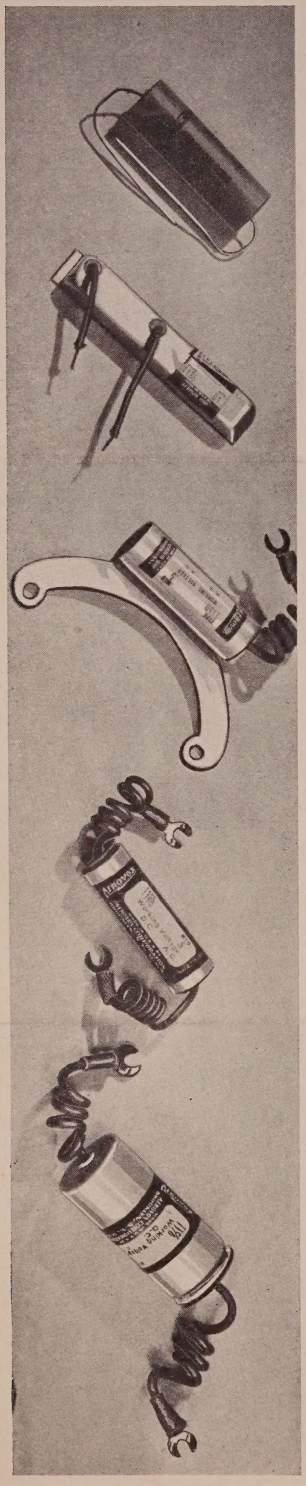
Of good radio books, there's a limit. With unlimited purse, shelf-space and time, the radio man has thousands of titles to choose from. But alas, most radio men cannot wade through the radio bibliography. A radio Dr. Elliott must come to their assistance with a condensed radio literature, and a fiv-inch shelf is about all the busy service shop can spare.

And so to A. A. Ghirardi, an eminent radio writer, who presents the radio fraternity with two books constituting an ideal radio training and reference library. First, there is his "Radio Physics Course", a complete, up-to-date, authoritative electrical and radio course which answers every question on radio, electricity, photo-electric cells, television and the talkies. The information in this book provides an excellent foundation for a radio career. And, it's easy reading, despite the serious nature of the text. Only $4.00—mighty little for a big, chuckful, handsome volume of practical information.

Then there's "Modern Radio Servicing"—a literary kit for the service man. The entire gamut of service problems is run by this book. And its authors, A. A. Ghirardi and B. M. Freed, have kept it right up to date through successive editions, even to including the very latest data on testing instruments and cathode ray oscillographs, new tubes and circuits. This book with its 1300 pages and 706 illustrations is yours for $4.00.

Data contained in these books answer many of the questions which have been asked by readers of the Research Worker, especially in regard to the use of interference filters and auto-radio condensers. What's more, the authors have chosen to illustrate their text with AEROVOX products as typical devices.

Copies of these books may be ordered through us, or direct from the publishers, Radio Technical Pub. Co., 45 Astor Place, New York City.



AUTO RADIO CONDENSERS

AEROVOX offers a complete line . . . a cure for every auto-radio noise . . . including generator, dome-light filter, ammeter, vibrator and other condenser units. Also replacement units. And as usual, thoroughly engineered for the given function.

Do grant these auto-radio sets a square deal! Remember, they cannot display their remarkable sensitivity, selectivity and excellent tone unless background noises are kept at a minimum with AEROVOX auto-radio noise eliminating devices. Here's a condensed listing of these units:

SUPPRESSOR CONDENERS

Type No.	Cap.	Size	List Price
1120	1.	1¼″ x 2⅛″	$.75
1140	.5	21/32″ x 2″	.50

AMMETER CONDENSERS
For Auto Radios

*1160	.5	21/32″ x 2″	.50
*1170	1.	1″ x 2⅛″	.75

DOME LIGHT FILTER CONDENSER
For Auto Radios

*1180		1″ x 2⅜″	1.00

OIL IMPREGNATED VIBRATOR CONDENSERS
(Wax Filled)

*1135	.01	⅜″ x 9/16″ x 3⅜″	.60
*1135	.5	⅜″ x ⅞″ x 3⅜″	.65

*Denotes new items not listed in Aerovox 1935 catalog, (Third Edition).

OIL FILLED VIBRATOR CONDENSERS

Type No.	Cap.	Size	List Price
1130	.007	1″ x ⅞″ x 9/32″	.45
	.01	1″ x ⅞″ x 9/32″	.45
	.02	1″ x ⅞″ x 9/32″	.45
	.03	1″ x 1⅛″ x 9/32″	.45
	.04	1″ x 1⅛″ x 9/32″	.45
	.05	1″ x 1⅛″ x 9/32″	.45
	.06	1″ x 1⅛″ x 13/32″	.45
	.07	1″ x 1⅛″ x 13/32″	.45
*1131	.007	1″ x 1¼″ x 9/32″	.45
*1131	.01	1″ x 1¼″ x 9/32″	.45
*1131	.02	1″ x 1¼″ x 9/32″	.45

VIBRATOR CONDENSERS
(Tubular Paper Type)

*1684	.007	½″ x 1½″	.30
*	.01	½″ x 1½″	.30
*	.02	9/16″ x 2″	.40
*	.03	9/16″ x 2″	.50
*	.04	11/16″ x 2″	.55
*	.05	11/16″ x 2″	.55

SUPPRESSOR CONDENSER
For Ford Auto Radios

*1150	.05	21/32″ x 2″	.60

Install these units! Learn what 1935 auto-radio performance really is like. For by taking proper pains with those auto-radio installations, and giving auto-radio owners good service and lasting satisfaction, you can get your share of auto-radio trade, service and profits.

UP-TO-DATE DATA

Between frequent catalog editions we are issuing catalog supplements covering the latest additions to the steadily growing AEROVOX line of condensers and resistors. Unless you are getting this up-to-the-minute literature, be sure to write in for same.

AEROVOX CORPORATION

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